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A RELATIONAL STRUCTURE FOR DOCUMENT RETRIEVAL IN CODING THEORY

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This paper defines a relational data structure designed for a document retrieval system in Coding Theory. The structure consists of a heirarchy tree structure and a functional structure known as a Lateral Link. The retrieval functions of the Lateral Links are to bring up the possibility of ambiguity, suggest related search topics, and propose the elimination of irrelevant topics. An outline of the application of this data base to a retrieval system is presented, along with suggestions for further studies leading to implementation of such a system.

ACKNOWLEDGEMENT

I wish to express my gratitude to Professor R. T. Chien and to Fred Stahl for their guidance, advice, and criticism throughout the process of researching and writing this paper. I owe a special thanks to my wife, Carol, for her constant support and understanding. Thanks are extended also to Mrs. Sherry Kallembach for her preparation of the manuscript.

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I. INTRODUCTION

The goal of this project, of which this paper is a part, is to develop a document retrieval system whose output is highly relevant to the request, and which accesses all or nearly all such documents in its file. In final form, this system will accept requests made in natural English. This paper deals specifically with the problem of developing a data base for such a system. The data base is a structure which can display, in a coherent manner, the various concepts involved in a given discipline, and their relation to each other. The corpus has been confined to the area of Coding Theory, but it is expected that the results obtained will be applicable to other areas as well.

Chapter II will present a detailed description of the model structure developed, with examples.

In Chapter III, some suggestions for using this data base in an actual retrieval system will be outlined.

All figures and tables referred to throughout the text are located in the Appendix, due to their length.

II. THE MODEL

1. Derivation

The approach taken in deriving the model for Coding Theory was to treat this entire subject area as describing the steps taken to solve the coding problem, as interpreted by Ash,[1] Peterson,[2] and Berlekamp,[3] among others. Accordingly, in the first stage of constructing the model, seven phases of the solution to this problem were defined. Each phase was then broken down as a seperate hierarchical tree. An important aspect of these trees was that the breakdown at each node was not determined strictly on a genus-species, or set-subset basis. Instead, provision was made for including other types of relations within the hierarchy structure.

The second stage of constructing the model was to identify and classify the relations which existed between nodes, or groups of nodes, which could not be displayed by the use of a hierarchy tree, or which were precluded by the specific design of those trees used in the model. These are called Lateral Links, and they give the structure greater flexibility for use in processing a request, for they can be used to select new possibly relevant areas to include in a search, as well as to discriminate between related, but irrelevant topics.

In analyzing the details of the Lateral Links, it was discovered that they all possessed a similarity of structure. They can all be expressed as "if--then" relations between one group of nodes and another group which is constrained by a set of rules peculiar to each type of link-relation found. Further, these link-types can be grouped according to similarity of their inherent rules, or functions as they will be referred to henceforth. Finally, the link-types may be arranged in order according to the definiteness or surety of their particular implications. A detailed description of each stage of the model follows, and the model is graphically represented in Figures 1-8 and Table 1.

2. The Model Structure

Coding Theory, the subject area chosen for this document retrieval project, as a body of literature, can be thought of as the descriptions and development of means for solving the coding problem. For the purposes of this particular data base, this is taken to include all topics from the decision to transmit information, in coded form, through some medium, to the construction, testing, and use of the actual system. This process is broken down into seven steps, as follows.

I. The Given: The channel and its characteristics, a code-symbol set, and possibly a metric function.

II. Determining the needed system capabilities.

III. Finding a code to suit these capabilities.

IV. Determining a decoding scheme.

V. Implementation as hardware.

VI. Simulation, for checking prior to use.

VII. Evaluation of the system.

Each of these steps defines the subject area covered by one hierarchy tree in the model. The reliance of the model on topics in the literature can be shown better by an outline of the areas referenced by each primary branch in the trees.

I.

A. Channel Models: References documents on abstract mathematical models of information channels.

B. Code Symbol Set: Serves as a limiter applicable to topics in the rest of the model, e.g., binary codes.

C. Errors: In real channels with real codes, what kinds of errors are anticipated?

D. Metric Function: Serves as a limiter similar to B. above, e.g., Lee distance.

II.

A. Merits and problems of attaining various types of decoding capabilities.

B. Desirability of different rates of redundancy.

C. Considerations about lengths associated with codewords.

D. Decisions as to the required number of distinct messages.

E. Problems of Synchronization.

III.

A. Studies of the tradeoffs among constraints. Topics which lend insight into the realization of constraints.

B. Methods for constructing codes.

C. Explanations and further developments of existing codes.

D. Methods for determining properties and capabilities of existing codes.

IV.

A. What kind of information does a particular decoding scheme give concerning the presence of errors?

B. Decoding schemes.

C. Extent of a decoding scheme.

V.

A. Hardware for decoding.

B. Hardware for encoding.

VI.

A. Simulation Methods

B. Criteria for judging the effectiveness of a simulation.

C. Results from simulations performed.

VII.

A. Evaluations as to system complexity.

B. Evaluations of throughput--cost effectiveness tradeoffs.

C. Relation of system rate to theoretical channel capacity.

A certain amount of redundancy is introduced by this method, since a good many of the ideas useful to one of these areas are useful to others as well. However, it will be indicated later that this inherent property of the model can be put to good use in a document retrieval sense. Further information about the above topical subdivisions can be obtained from the actual tree diagrams, Figures 1-8.

As was mentioned earlier, the construction of the trees allows for information other than a strict genus-species, or set-subset relationship between two nodes. This is accomplished by defining a second type of branch, called an Aspect branch. Aspect branches are denoted in the figures by an "A" near the middle of each such branch. These branches are used to delineate topical subdivisions under a given node which are intimately related to it and necessary to a thorough understanding of the subject the node represents, but which, nevertheless, cannot rightfully be deemed subsets. Tree III.A.,

Figure 4, contains two good examples of this. The node marked "Optimum Codes," for instance, is divided into two Aspect branches, each labelled by the aspect referred to--in this case "Types" and "Properties". Another slightly different example is for "Permutation Groups," located in the same tree. Here "Types" is again singled out, but the other aspect of this node is "Uses".

The preceding description of the trees which form the basis of the model is not very different from many hierarchy structures used in the current technology in document retrieval. The second model structure is added to the tree structure to give more flexibility, and consequently more potential, to the retrieval system. The inclusion of the Lateral Links transforms the simple tree structure into a relational structure with the property that relations can be mapped out among any nodes necessary. However, since these special relation-links are treated differently from the tree branches, the structural simplicity and ease of handling inherent in a tree structure are retained. Also, due to the broad definition of these links, it is possible to relate whole groups of nodes, not just two.

Before defining the Lateral Links, it is necessary to consider briefly a few of the preconceptions about retrieval applications of the model which are implied in the definition. This topic will be more fully covered in Chapter III.

It is intended that each document in the collection will be indexed according to whether or not nodes in the tree structure are applicable to the content of that document. It is the function of the system to produce a "list" from these same index nodes which will fulfill the user's needs when used to retrieve the documents. Thus, the idea is to access all relevant nodes possible, as well as to eliminate all irrelevant nodes. This is indeed the main purpose for including the Lateral Links in the model.

A Lateral Link (LL) can be defined symbolically as follows:

$$f(N) = f(n_1, n_2, \ldots, n_q) \longrightarrow g(m_1, m_2, \ldots, m_t) = g(M).$$

The n_i and m_j are nodes in the tree structure, and f is a logical function of the nodes of N. The function g determines the following information:

1. Type A or Type B. Type B links are used either for suggestion of additional node-topics relevant to the initial request, or for elimination of node-topics which are irrelevant. Type A links are used for differentiation among nodes, where a possibility of ambiguity exists. This process may call for decisions to be made regarding both suggestion (or retention) of nodes and elimination of nodes within a single LL. This is not the case in Type B, in which only one type of decision is called for by any one LL.

2. Specific information about the relation implied between the two groups of nodes.

3. Co-occurrence for retrieval. In many Type B links, the m_j are constrained by an AND relation, or an OR relation. The AND relation suggests that retrieval should be limited to documents indexed by all the m_j in that link, rather than merely any of them, as signified by the OR relation.

As an example of a Type A link, consider Lateral Link 1 from Table 1. As in all Type A links, M = N. The nodes listed express the same idea, but the focus of attention is different in each node. This characteristic relationship defines a specific category of Type A links. There are 3 such categories defined among the Type A links, and 9 among the Type B. links. Thus, "LL 1" is of Type A-1. In this particular link, one node considers the codes from the point of view of existing codes which may be decomposed into products of other codes. The other node looks at it as a constructive process of creating a code from a product of existing codes. The difference may or may not be important, for while the decomposition aspect may be important for decoding considerations, the constructive aspect has usefulness in considering the acquisition of a code which meets certain requirements such as distance, rate, and word length.

An example of a Type B link is number 74 in Table 1. This is a case of definition by a combination of characterizing properties, or Type B-5. It suggests that a code which meets the Hamming bound (where tight), is the same as a so-called optimal code with a high rate. Here it is important that the AND be included in g. Both nodes in M are needed, since optimal codes may have various rates, and high rate codes are not all optimal. The f function is AND because the entire set of properties listed is necessary for correct definition.

In this manner, the entire set of LL's given in Table 1 is arranged by the 12 categories below, according to the particular functions involved in f and g. The categories are roughly ordered according to increasing definiteness of the implication described, i.e., by increasing possibility for an automatic decision without further outside information.

Type A: In Type A, M = N, f and g are OR relations, and the object is differentiation among the nodes presented.

1. The nodes express the same idea, but are different approaches to it.
2. The nodes all contain the same term, used in very different contexts.
3. The nodes all contain the same index term, which appears in several different locations as a consequence of the particular tree structure chosen.

Type B: In all Type B categories except B-8, $M \neq N$.

1. Nodes in M give more specific or more detailed information about the node-topics in N. The function f is the identity function; g is an OR where applicable, and the purpose is to suggest new nodes.

2. Nodes in M are decoding methods to be used specifically with the items in N. The functions f and g are OR, and the purpose is to suggest new nodes.

3. Nodes of M are "tools" for accomplishing "goals" in N, or M gives a code type for correcting an error type in N. The function f depends on the individual link; g is an OR, and the purpose is to suggest new nodes.

4. The node in N lists a topic which can be completely determined by knowledge of the node-topic in M. The purpose of this link is to suggest a new node.

5. N contains a set of properties, which may be taken together to define the nodes in M. The function f is an AND, while g is either an AND or OR depending on the individual link. The purpose is to suggest new nodes.

6. N contains a set of properties. M contains bounds or limiting cases which set mutual constraints on members of N. The function f depends on the individual link, and g is an OR. The purpose is to suggest new nodes.

7. M lists nodes which can be derived from, or are special cases of nodes in N. The f and g functions are both OR where applicable, and the purpose is to suggest new nodes.

8. A Qualifier link. The presence of one node and any one or more of a group of others demands that all of these nodes be accessed. Here N = M. The f function is of the general form x AND (y OR z OR w ...); g is an AND, and the purpose is to suggest new nodes.

9. A Qualifier link. The presence of the nodes in N demands the exclusion of the nodes in M. The f and g functions are AND, and the purpose is to eliminate unwanted nodes.

Type B relations 1 through 7 will also define LL's by interchanging f(N) and g(M), i.e., the relations can be meaningfully defined in two directions. This brings the total number of categories of LL's to 19.

While the LL's defined in this chapter were derived for the Coding Theory data base which is the subject of this paper, it is hoped that this set of categories is general enough to be used in similar implementations of other data bases, without significant alterations or augmentations.

III. APPLICATIONS

Although it is not the purpose of this paper to develop a complete retrieval system, it has already been shown that the model for the data base was derived with some ideas for its application in mind.

The model was designed to access primarily technical papers, which have a narrow focus of subject matter. Therefore if textbooks are desired in the retrieval collection, they should be subdivided by individual chapters or even sections within chapters, each treated as a separate document. As was previously stated, each document is to have been indexed according to its inclusion of topics indicated by nodes in the model. It is expected that at least full document abstracts will have to be used in order to obtain this information with precision. Since the nodes as shown in the model are referenced by only one index word or phrase, a fairly comprehensive thesaurus must be constructed for each node. A small synonym dictionary is included as Table 2, as an example of the type of data to be included.

The actual processing of a request can be outlined by a simple analogy. Let each node in the model be represented by a light bulb. When a request is received, it is analyzed to detect the occurrence of index terms or the corresponding terms included in the thesauri. For each index term found, lights corresponding to it are turned "on". However, it is conceivable that the thesauri, in order not to miss valuable data in the request, may overlap one another where certain words or phrases are used differently or with ambiguity. In this case, more lights would nearly always be "on" than are necessary, or even desired. Also, unless the request is very detailed, there may be some bulbs still "off" after analysis of the initial request, which refer to topics not included in the request, but nonetheless quite relevant to it.

It is the job of the LL's to correct this situation. The system should be designed to make decisions, possibly with the aid of the user but ideally without such help, as the LL's bring them up. After such processing, those bulbs which remain "on" should have a good chance of producing relevant documents when some "best-fit" index matching technique is applied. In addition, the use of the LL's generates information about desirable co-occurrence relations among lighted nodes, and the non-desirability of rejected nodes, which if taken into account should improve the index matching process.

A careful analysis will reveal that it will prove necessary to define a hierarchy for the use of some of the LL's, so that unwarranted decisions will not be called up as a consequence of prior LL decisions, or similarly so that important decisions will not be omitted. A scheme might also be incorporated to shorten the processing time required by considering first those LL's which are referenced at higher, more general levels in the tree structure. This may automatically eliminate some unnecessarily redundant LL decisions at lower levels in the tree structure.

It may prove rewarding to include schemes for considering father-son-brother relationships in the tree structures in order to generate more possible clues for retrieval, as has been done in the past. The merits of feeding the processed node group back through the system one or more times should also be studied.

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APPENDIX

EXPLANATION OF FIGURES

The following figures are diagrams of the subtree structures referred to in the text. They are in numerical order by their primary nodes, except for pages which include several small subtrees grouped together, in which case slight deviations from strict numerical order occur.

Numbers located next to each node are used in Table 1 to refer to the nodes. The first number indicates the "row" of the individual subtree, the number following the decimal is the position from the left of the row, e.g., 5.4 would be in the 5th row after the primary node, four nodes from the left.

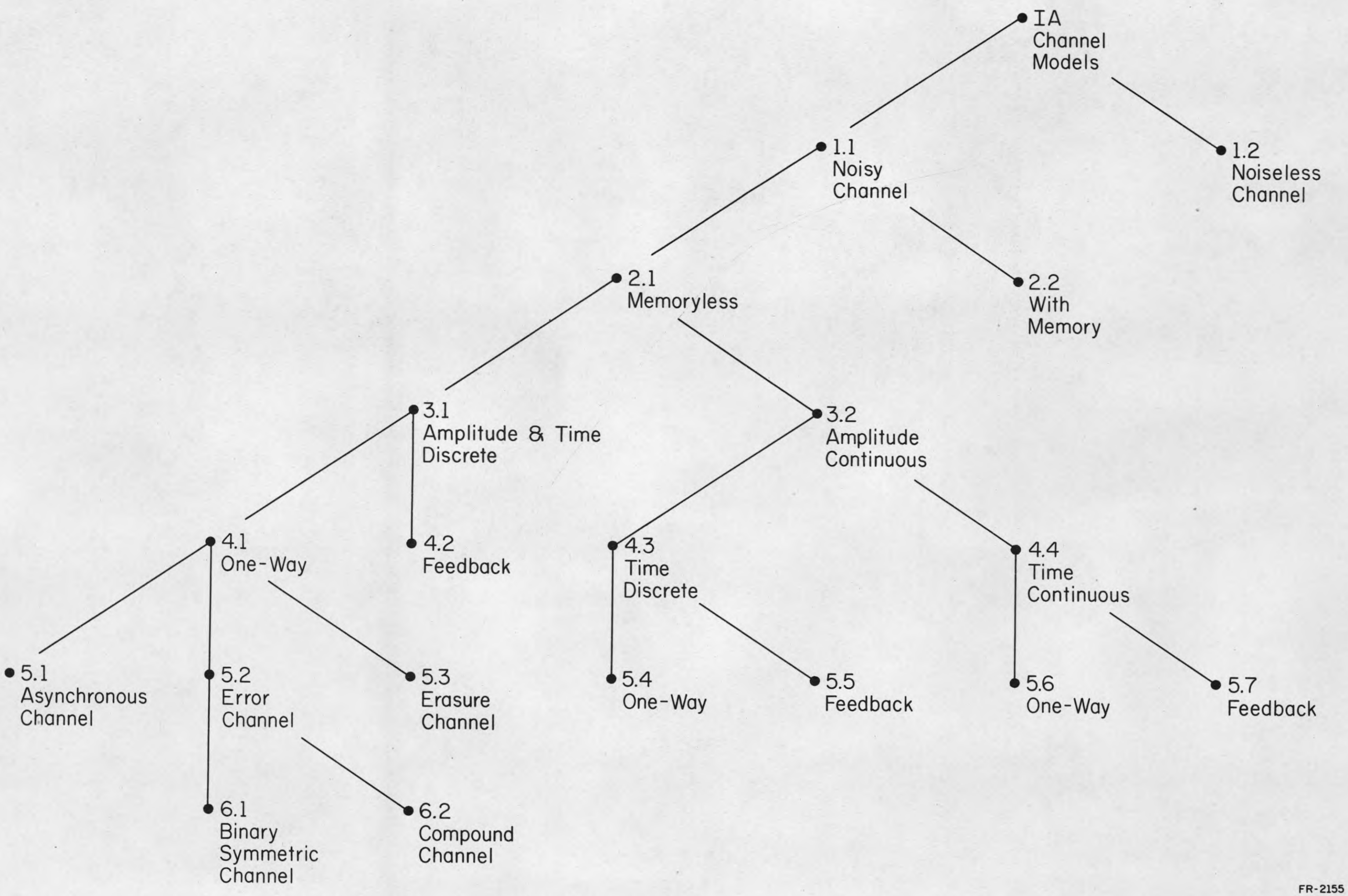

Figure 1. Subtree IA

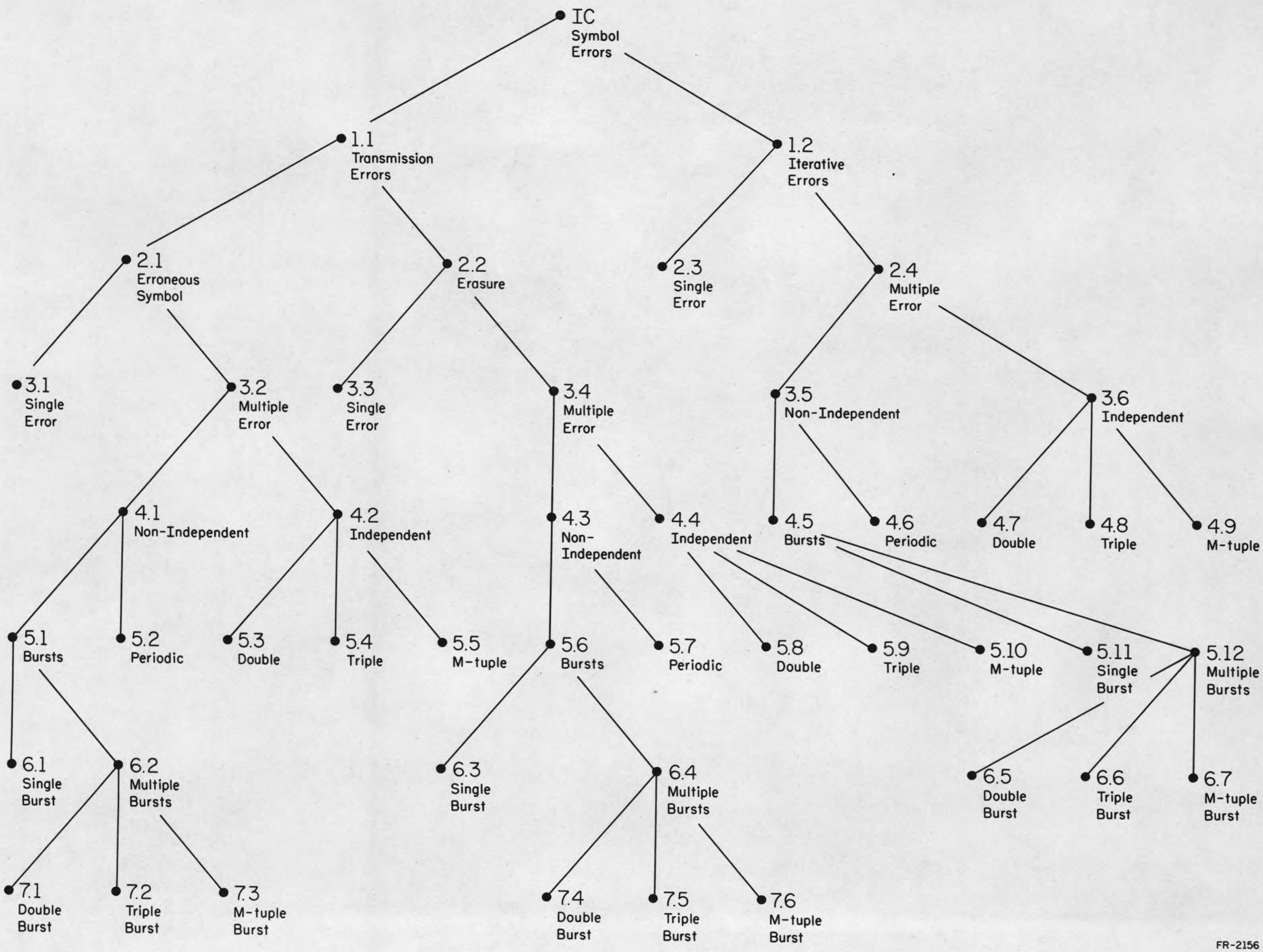

Figure 2. Subtree IC

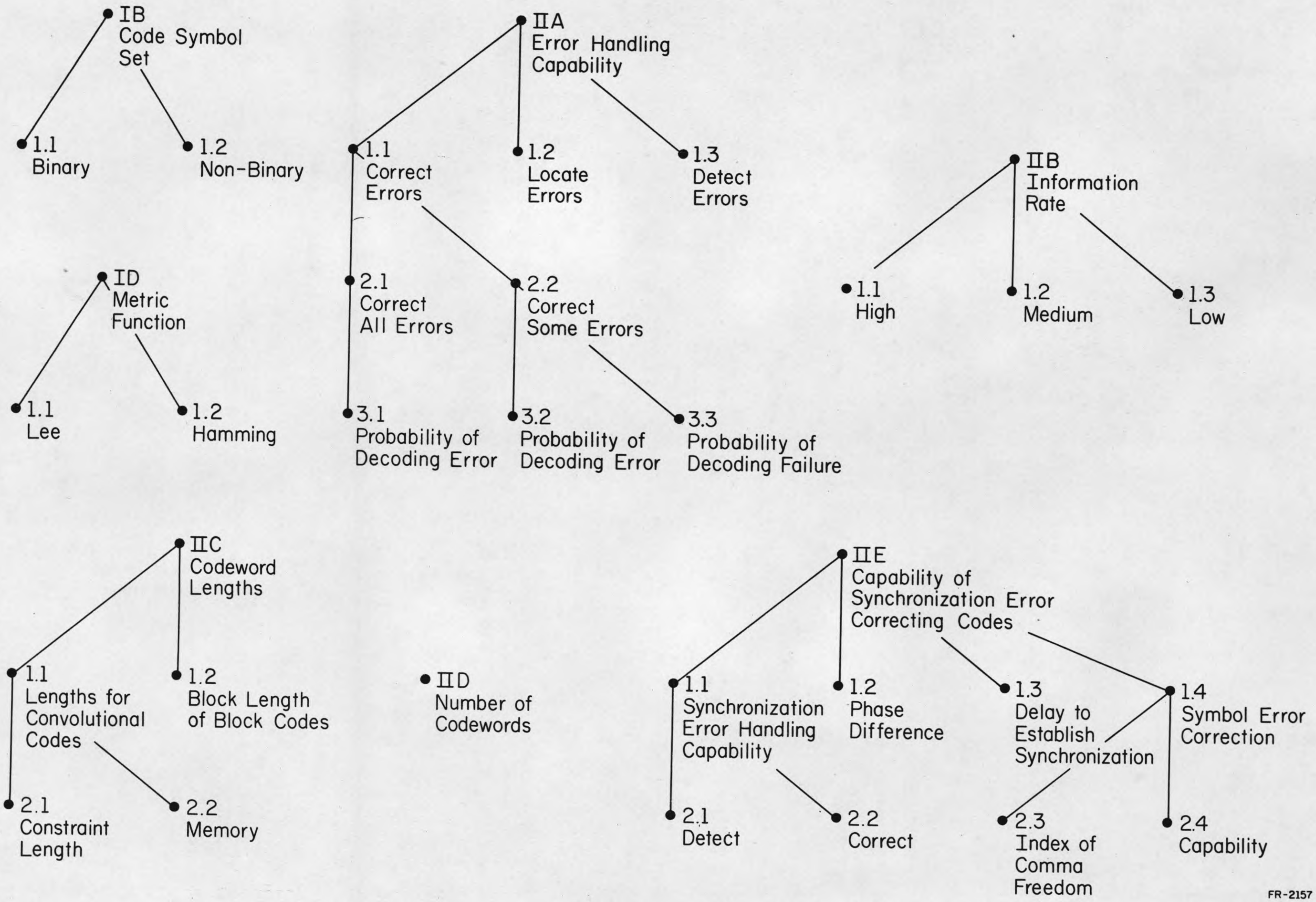

Figure 3. Subtrees IB, ID, and IIA-IIE.

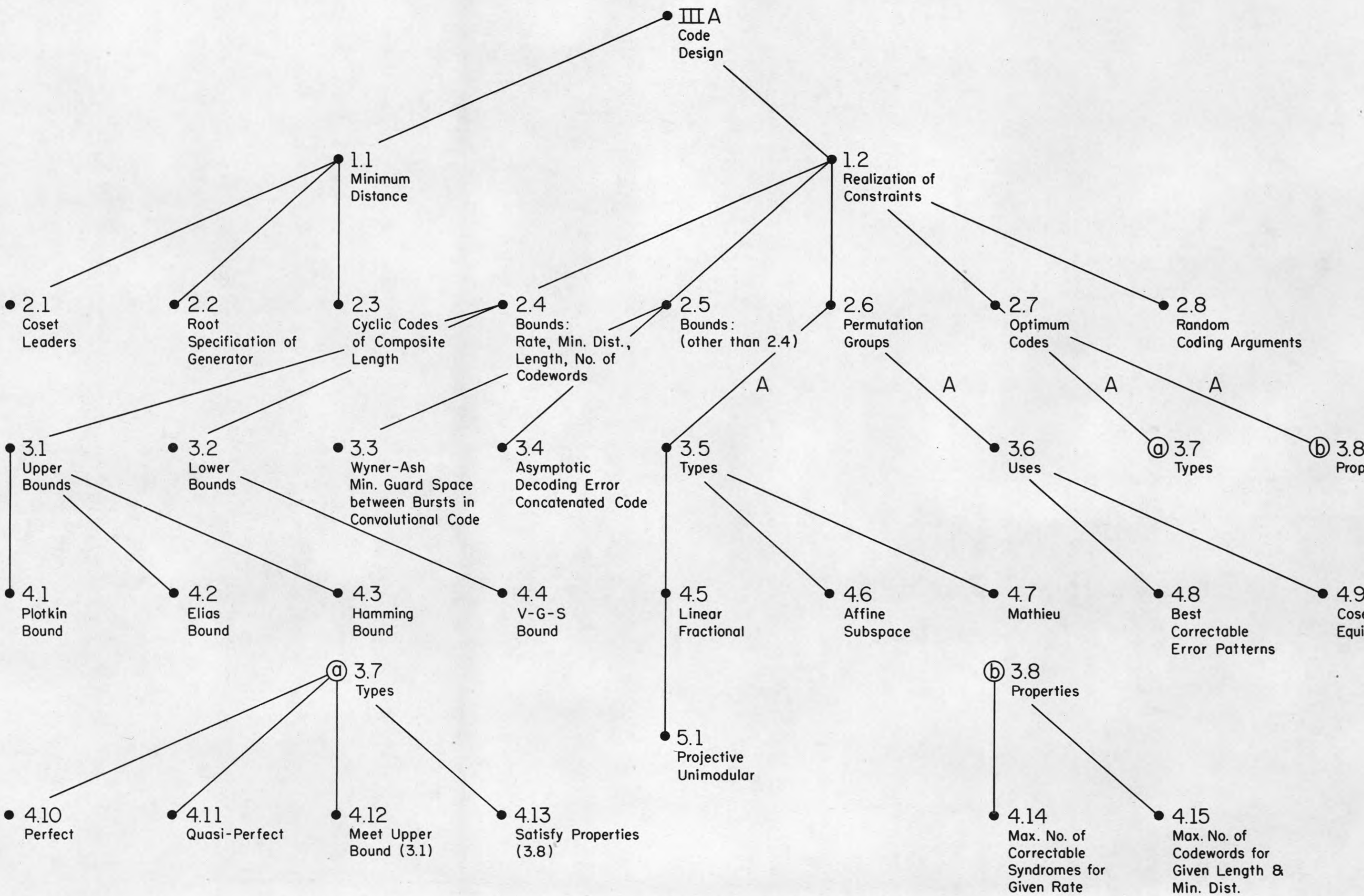

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Figure 4. Subtree IIIA

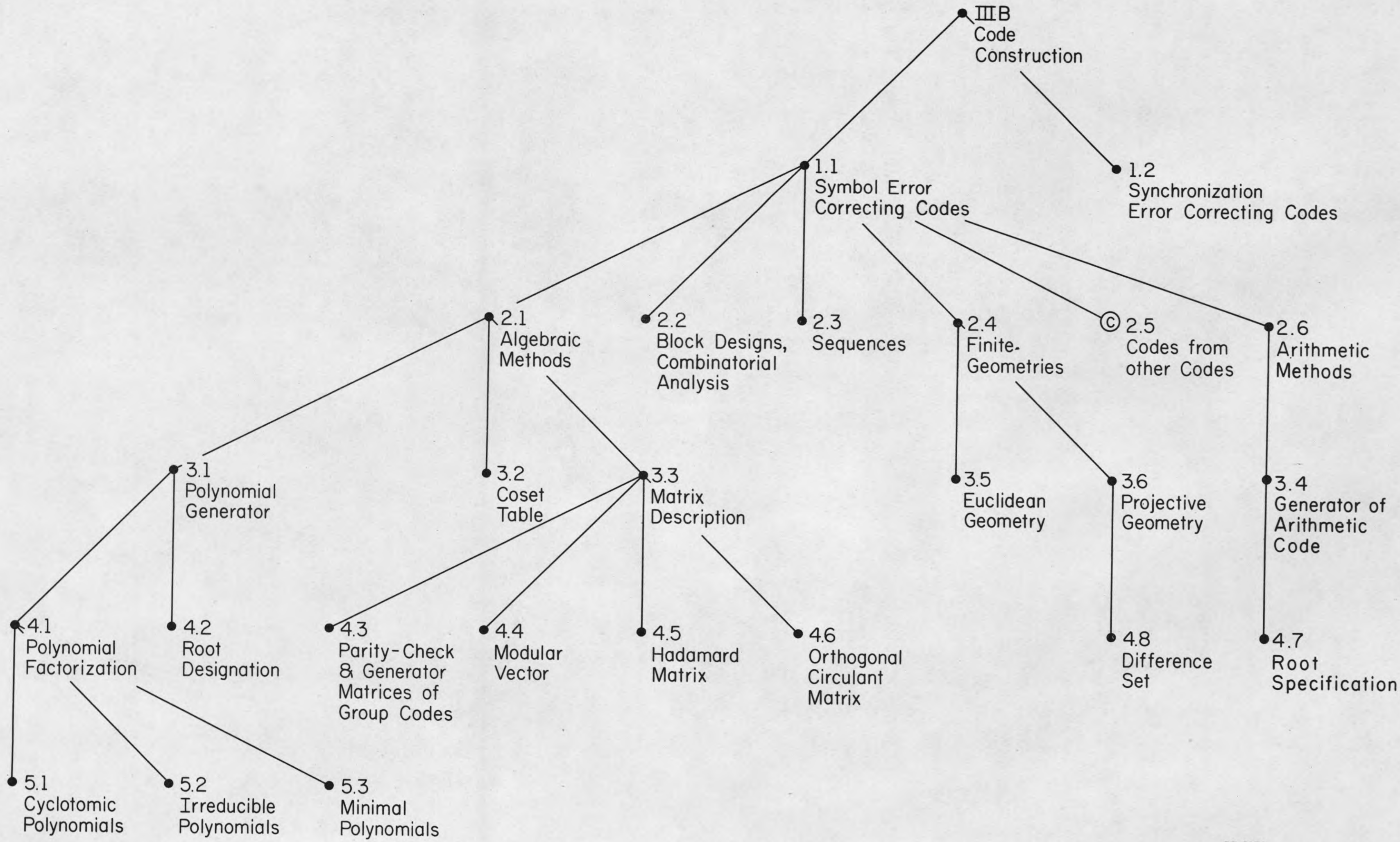

Figure 5.a. Subtree IIIB

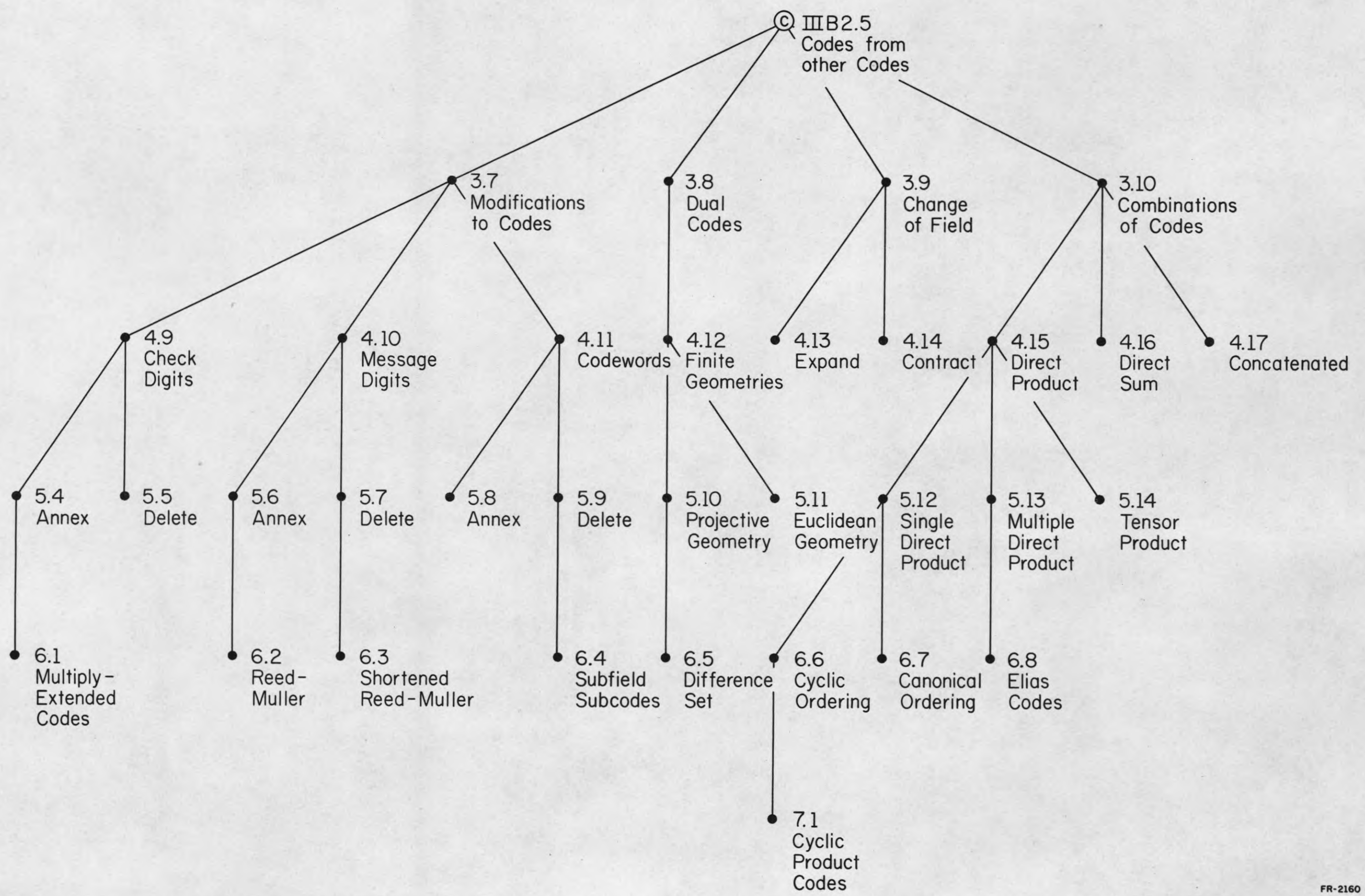

Figure 5.b. Subtree IIIB, continued

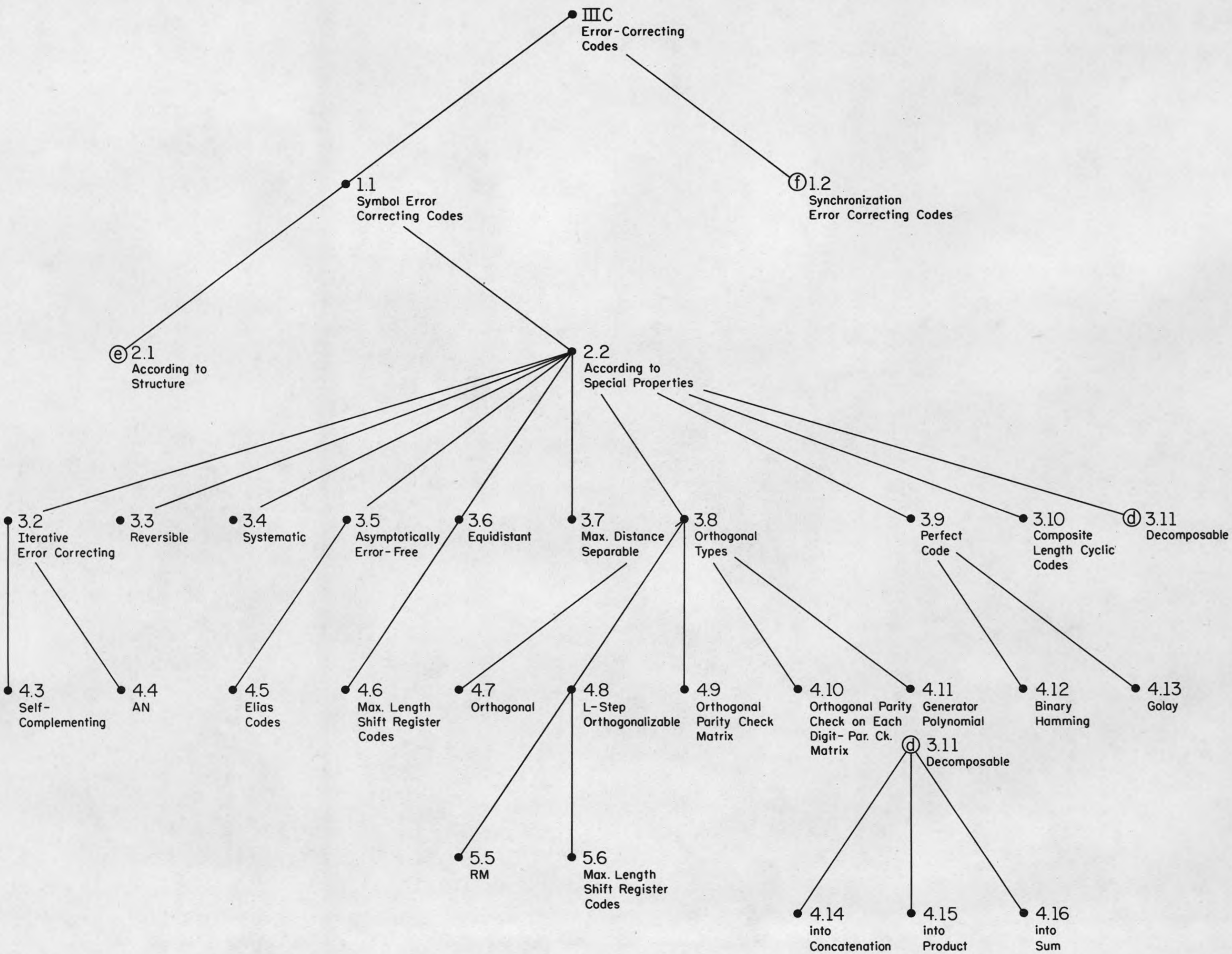

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Figure 6.a. Subtree IIIC

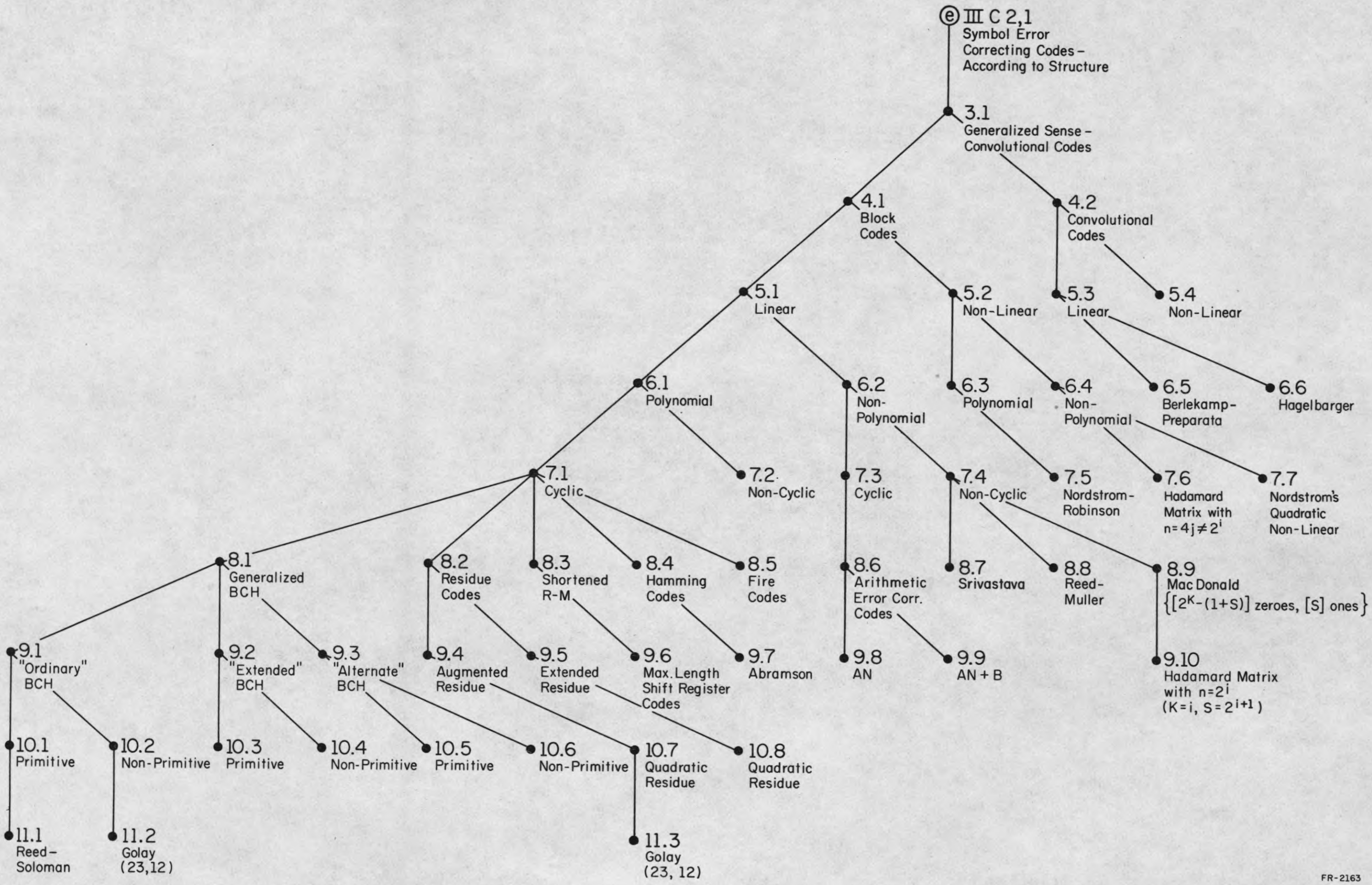

Figure 6.b. Subtree IIIC, continued

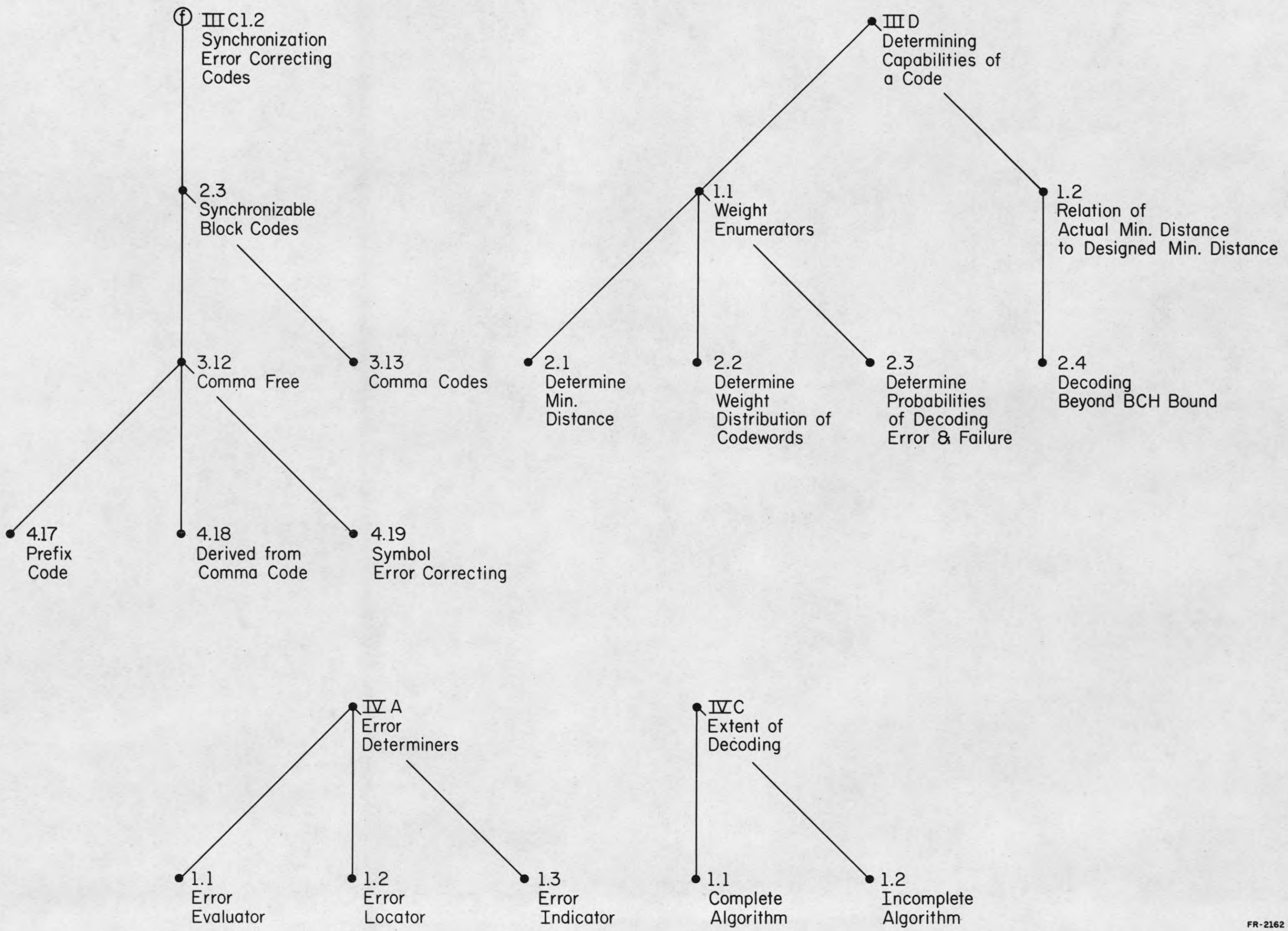

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Figure 6.c. Subtree IIIC, continued; and Subtrees IIID, IVA, IVC

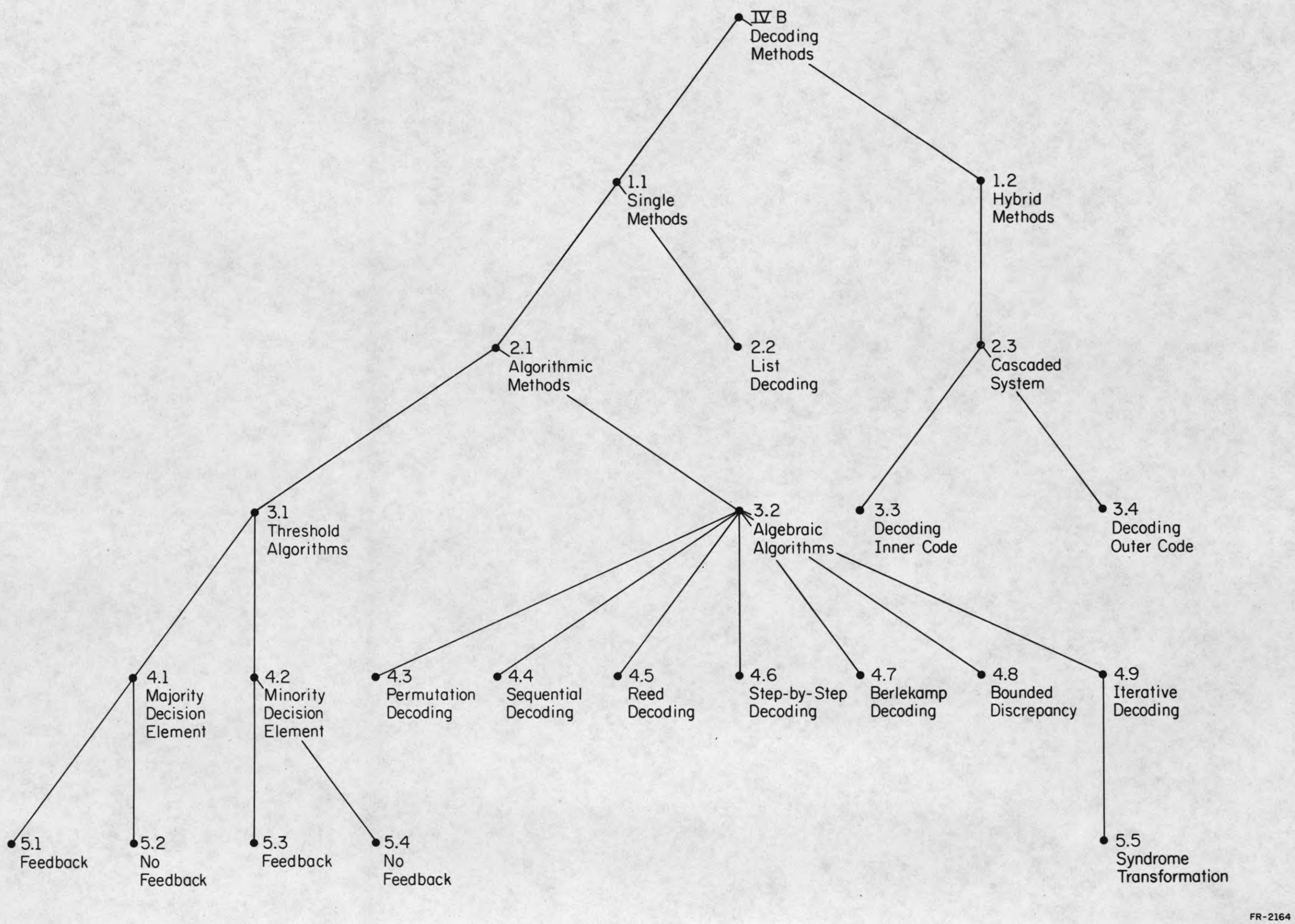

Figure 7. Subtree IVB

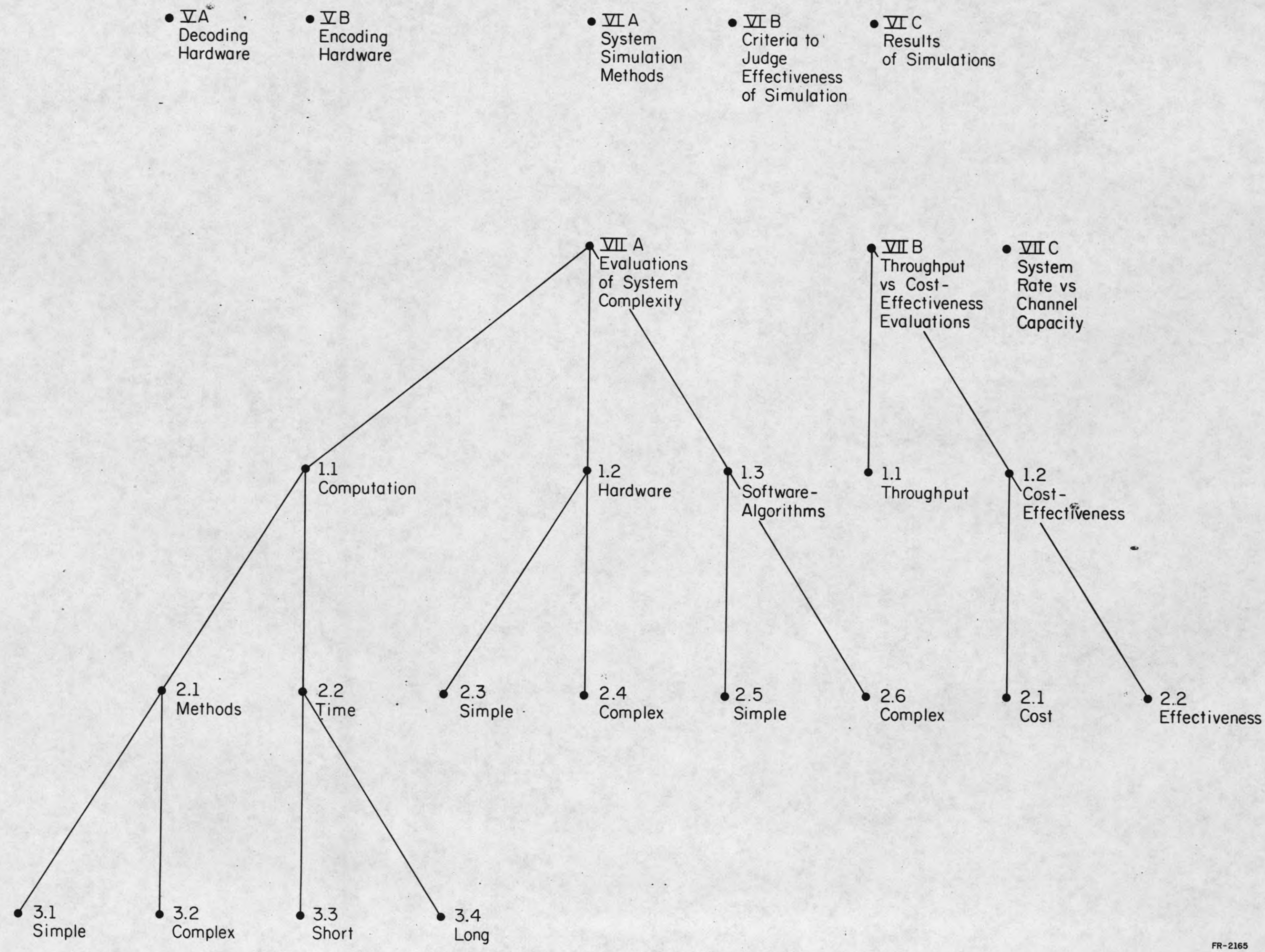

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Figure 8. Subtrees VA, VB, VIA-VIC, VIIA-VIIC

EXPLANATION OF TABLE 1

Table 1 is a list of the Lateral Links. The only Functional Data included in the table is information which is not a common feature of all examples of a given link-type. Such common features are described in the main text. Nodes involved in each link are listed by the coordinate numbers used in the figures. Also included in the table is a Brief Word Description of the information to be related by each link.

Table 1

Lateral Links

Link Number	Functional Data	Brief Word Description
(No's 1-4 are Type A-1)		
1.	M=N=(III B4.15, III C4.15)	Products of codes-- Decomposition vs. Combination
2.	(III B4.16, III C4.16)	Sums of codes-- Decomposition vs. Combination
3.	(III B4.17, III C4.14)	Concatenations of codes-- Decomposition vs. Combination
4.	(IV B, V A)	Decoding methods-- Schemes vs. Hardware
(No's 5-8 are Type A-2)		
5.	M=N=(I A2.2, II C2.2)	"Memory"-- Of channel vs. Of convolutional code
6.	(I A4.2,5.5,5.7, IV B5.1,5.3)	"Feedback"-- Channel type vs. Decoding
7.	(I A2.1, III C4.1)	"Memoryless"-- Channel vs. Convolutional Code
8.	(III C2.3, 4.1)	"Block codes"-- Error correcting vs. Synchronizable
(No's 9-49 are Type A-3)		
9.	M=N=(I A4.2, 5.5, 5.7)	Feedback Channels
10.	(I A3.1, 4.3)	Time-discrete channels
11.	(I A4.1, 5.4, 5.6)	One-way channels
12.	(I C2.3, 3.1, 3.3)	Single errors

Table 1 (cont'd)

Link Number	Functional Data	Brief Word Description
13.	M=N=(I C2.4, 3.2, 3.4)	Multiple errors
14.	(I C3.5, 4.1, 4.3)	Non-independent errors
15.	(I C4.2, 4.4, 3.6)	Independent errors
16.	(I C4.5, 5.1, 5.6)	Burst errors
17.	(I C4.6, 5.2, 5.7)	Periodic errors
18.	(I C4.7, 5.3, 5.8)	Double errors
19.	(I C4.8, 5.4, 5.9)	Triple errors
20.	(I C4.9, 5.5, 5.10)	M-tuple errors
21.	(I C5.11, 6.1, 6.3)	Single bursts
22.	(I C6.5, 7.1, 7.4)	Double bursts
23.	(I C6.6, 7.2, 7.5)	Triple bursts
24.	(I C6.7, 7.6, 7.3)	M-tuple bursts
25.	(I C5.12, 6.2, 6.4)	Multiple bursts
26.	(II A3.1, 3.2)	Probability of decoding error
27.	(III A2.2, III B4.2, 4.7)	Root specification
28.	(III A2.3, III C3.10)	Cyclic codes of composite length
29.	(III B4.5, III C7.6, 9.10)	Hadamard Matrix codes
30.	(III B2.4, 4.12)	Finite geometries
31.	(III B3.5, 5.11)	Euclidean geometry
32.	(III B3.6, 5.10)	Projective geometry
33.	(III B4.8, 6.5)	Difference set codes
34.	(III B6.2, III C8.8)	GRM codes
35.	(III B6.3, III C8.3)	Shortened RM codes
36.	(III B6.8, III C4.5)	Elias codes

Table 1 (cont'd)

Link Number	Functional Data	Brief Word Description
37.	N=M=(III C11.2, 11.3, 4.13)	Golay codes
38.	(III C10.7, 10.8)	Quadratic Residue codes
39.	(III C4.6, 5.6, 9.6)	Maximum length shift register codes
40.	(III C3.2, 8.6)	Arithmetic error correcting codes
41.	(III C4.4, 9.8)	AN codes
42.	(III C10.1, 10.3, 10.5)	Primitive BCH codes
43.	(III C10.2, 10.4, 10.6)	Non-primitive BCH codes
44.	(III C7.1, 7.3)	Cyclic codes
45.	(III C6.1, 6.3)	Polynomial
46.	(III C7.2, 7.4)	Non-cyclic linear block codes
47.	(III C6.2, 6.4)	Non-polynomial block codes
48.	(III C5.1, 5.3)	Linear codes
49.	(III C5.2, 5.3)	Non-linear codes
(No's 50-54 are Type B-1)		
50.	M=(I C1.1); N=(I A4.1)	One-way amplitude and time discrete channel --- Transmission errors
51.	M=(I C2.1); N=(I A5.2)	Error channel-- Erroneous symbol errors
52.	M=(I C2.2); N=(I A5.3)	Erasure channel-- Erasure errors
53.	M=(II E); N=(I A5.1)	Asynchronous channel-- Capability of Synch. error correcting codes

Table 1 (cont'd)

Link Number	Functional Data	Brief Word Description
54.	M=(IV B2.2); N=(III C6.1, 6.3)	Polynomial generator--Polynomial codes
(No's 55 and 56 are Type B-2)		
55.	M=(IV B2.2); N=(III B3.2)	List decoding--Coset table
56.	M=(IV B1.2, 2.3); N=(III B4.7, III C3.11)	Hybrid decoding, Cascaded decoding--Decomposable codes, Concatenated codes
(No's 57-70 are Type B-3)		
57.	M=(III C8.5, 9.7); f(N)=(I C5.1 AND II A1.1)	Codes used to correct Burst errors
58.	M=(III C1.2, 8.6); f(N)=(I C1.2 AND II A1.1)	Codes used to correct Iterative errors
59.	M=(IV A1.2); f(N)=N=(II A1.2)	Error locator is used to locate errors
60.	M=(IV A1.3); f(N)=N=(II A1.3)	Error detector is used to detect errors
61.	M=(IV C1.1); f(N)=N=(II A2.1)	Complete decoding algor. used to correct all errors
62.	M=(IV C1.2); f(N)=N=(II A2.2)	Incomplete decoding algorithm used to correct some errors
63.	M=(III D2.3); f(N)=(II A3.2 OR II A 3.3)	Weight enumerators used to find probabilities of decoding error & failure with incomplete decoding
64.	M=(III C1.2); f(N)=N=(II E)	Codes to correct synch. errors
65.	M=(III C4.17); f(N)=N=(II E1.4)	Codes to correct symbol errors and synch. errors

Table 1 (cont'd)

Link Number	Functional Data	Brief Word Description
66.	M=(III B2.2); f(N)=N=(III C4.9)	Block designs used to obtain orthogonal parity check matrix
67.	M=(III C3.3); f(N)=N=(III D2.4)	Reversible codes can be used for decoding beyond the BCH bound
68.	M=(III C3.4); f(N)=(IV B2.1 AND VII A2.5)	Systematic codes give a Simple decoding algorithm
69.	M=(III C3.4); f(N)=N=(IV B3.1)	Orthogonal codes give a threshold decoding algorithm
70.	M=(III C4.13); f(N)=N=(III D2.4)	Golay codes can be used for decoding beyond the BCH bound
71.	Type B-4 M=(III A1.1); N=(II A)	Decoding capability of a code is completely determined by its minimum distance.
(No's 72-81 are Type B-5)		
72.	M=(I A6.2); N=(I C4.2, 5.1)	Burst and independent errors define a compound channel
73.	M=(III A4.10); N=(III A4.3, 4.12)	Perfect codes-- Meet Hamming bound
74.	g: AND ; M=(III A2.7, II B1.1); N=(III A4.3, 4.12)	Optimal codes of high rate-- Meet Hamming bound
75.	g: AND ; M=(III A2.7, II B1.2); N=(III A4.2, 4.12)	Optimal codes of medium rate-- Meet Elias bound
76.	g: AND ; M=(III A2.7, II B1.2); N=(III A4.1, 4.12)	Optimal code of low rate-- Meets Plotkin bound

Table 1 (cont'd)

Link Number	Functional Data	Brief Word Description
77.	g: OR ; M=(III B4.12, 5.10, III B5.11, 6.5); N=(III B6.4, III C8.1)	Geometric codes-- Subcodes of BCH
78.	g: OR ; M=(III B6.2, III C8.8) N=(III B5.6, III C8.3)	Reed-Muller code-- Lengthened, Shortened RM
79.	g: OR ; M=(III B6.3, III C8.3); N=(III B5.7, III C8.8)	Shortened RM-- Shortened, Reed-Muller
80.	M=(III C9.9); N=(III C4.3)	AN+B Codes-- Self-complementing Arith. error correcting
81.	M=(III C8.4); N=(III B5.5, III C8.8)	Hamming code-- Punctured RM
(No's 82-88 are Type B-6)		
82.	M=(III A3.3) M=(III A3.3) f(N)=I C5.1 AND(II C1.1 OR III C4.2)	Burst errors and lengths for convolutional codes-- Wyner-Ash bound
83.	M=(III A2.4, 3.1, 3.2); f(N)=(Any 2 of: II A, II B, II C1.2, II D, III A1.1)	Min. distance, word length, etc.-- Bounds
84.	M=(III A4.3); f(N)=[(Any two of: II A, II B, II C1.2, II D, III A1.1) AND II B1.1]	Min. distance, word length, etc., and high rates-- Bounds
85.	M=(III A4.2); f(N)=[(Any 2 of: II A, II B, II C1.2, II D, III A1.1) AND II B1.2]	Min. distance, etc. and medium rates-- Bounds
86.	M=(III A4.1); f(N)=[(Any 2 of: II A, II B, II C1.2, II D, III A1.1) AND II B1.3]	Min. distance, etc. and low rates-- Bounds

Table 1 (cont'd)

Link Number	Functional Data	Brief Word Description
87.	M=(III A4.15); f(N)=(II D AND(II C OR III A1.1)	Achieving max. number of codewords for given min. distance, word length
88.	M=(III A3.4, III C3.5); f(N)=N=(II A3.1)	Limiting cases of probability of decoding error
(No's 89-92 are Type B-7)		
89.	M=(III B4.5); N=(III B2.2)	Hadamard matrices can be derived from Block designs
90.	M=(III C7.1); N=(III B7.1,6.6)	Cyclic product code is a special case of a cyclic code
91.	M=(III C3.13); N=(III C4.18)	Comma free code can be derived from a comma code
92.	M=(III C3.3); N=(III C7.1)	Reversible code is a special case of a cyclic code
(No's 93 and 94 are Type B-8)		
93.	M=N=(I B1.1, I D1.1, 1.2) f(N)=[I B1.1 AND(I D1.1 OR I D1.2)]	Hamming and Lee metrics coincide in the binary case
94.	M=N=(I B1.1, II A1.1, 1.2) f(N)= [I B1.1 AND(II A1.2 OR II A1.1)]	In binary case Locate error = Correct error
(No's 95-97 are Type B-9)		
95.	M=(IV A1.1); N=(I B1.1, IV A1.2)	In binary case error evaluators are not used
96.	M=(I A6.1, III C4.12, 7.6, 8.5, III C8.9, 9.10, 11.1, 11.2); N=(I B1.2)	Non-binary case excludes anything which is exclusively binary
97.	M=N=(I B1.1, I B1.2)	The use of both Binary and Non-binary excludes the importance of either distinction.

Table 2

Synonym Dictionary

perfect code:	close-packed code
perfect code:	lossless code
linear block code:	group code
linear block code:	parity check code
linear block code:	(n,k) code
codeword:	word
codeword:	vector
codeword:	code vector
syndrome:	error pattern
convolutional codes:	tree codes
convolutional codes:	recurrent codes
direct product code:	interlaced code
direct product code:	multidimensional code
direct product code:	iterated code
direct product:	Kronecker product
maximum distance separable code:	maximum code
Primitive BCH codes:	narrow-sense codes
codeword in a code:	letter in the alphabet
BCH:	Bose-Chaudhuri
BCH:	Bose-Chaudhuri-Hocquenghem
detect:	determine existence
locate:	determine position
correct:	determine position and magnitude

Table 2 (cont'd)

Hamming bound:	sphere-packing bound
Hamming bound:	volume bound
Hamming bound:	Hamming-Rao bound
code dictionary:	code alphabet
code dictionary:	set of codewords
Plotkin bound:	average distance bound
independent error:	random error
arithmetic error:	iterative error
high information rate:	low redundancy
medium information rate:	medium redundancy
low information rate:	high redundancy
symbol:	digit
two-way channel:	feedback channel
decoding capability:	error handling capability
size of synchronization error:	phase difference
size of dictionary:	number of codewords
specification:	designation
delete codewords:	expurge code
annex codewords:	augment code
delete message digits:	shorten code
annex message digits:	lengthen code
delete check digits:	puncture code
annex check digits:	extend code

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13. ABSTRACT

This paper defines a relational data structure designed for a document retrieval system in Coding Theory. The structure consists of a heirarchy tree structure and a functional structure known as a Lateral link. The retrieval functions of the Lateral Links are to bring up the possibility of ambiguity, suggest related search topics, and propose the elimination of irrelevant topics. An outline of the application of this data base to a retrieval system is presented, along with suggestions for further studies leading to implementation of such a system.

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